

ENGINEERING

SYNTHESIS OF ELECTRONIC CIRCUITS IN SPICE WITH EVOLUTIONARY ALGORITHMS

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This research investigates evolutionary algorithms (EA's) as a means of automatically designing electronic circuitry in software. A software suite is developed for use on parallel GNU/Linux clusters that employs a descendant of the Berkely SPICE circuit simulation package to evaluate the relative successfulness of generated circuits in relation to a user-specified task. Tasks are specified in the form of a user-supplied objective function written in Python script that examines and rates the SPICE output waveforms. Darwinian natural selection is used to ensure that the “fittest” circuits survive to produce offspring in a cycle of competition and reproduction. Several types of circuits are successfully produced by the system, such as analog filters with various response curves, analog tone decoders, and a number of small digital logic circuits. In all tests, the software is allowed to use only a handful of component types: resistors, capacitors, and one type of NPN transistor.

The software package consistently produces circuits that perform their designated tasks well (in software simulation) but tend to have an unorthodox structure that makes them incomprehensible to a human engineer. The EA is driven stochastically toward a goal based only on simulation results and natural selection, and thus does not possess the traditional design frameworks and assumptions used by a human. As a result, the software is free to use electronic components in ways never considered by their designers. In some cases, the evolved circuitry can be more efficient than that which an engineer would create. It is this design novelty that is the primary strength of the EA approach, making it is capable of handling design problems for which no analytical solution is known.